Changing the maps of urban bat distribution

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Abstract
Over three decades after the establishment of the Birmingham and Black Country Bat Group, the results of just a few years of targeted advanced surveys at woodland sites in the green belt of the county have begun to challenge the misconceptions of bat assemblages in urban areas. The data from the Urban Bat Project have altered the distribution maps of species previously thought to be 'rare', 'very rare' or 'locally extinct' in the county. The rediscovery of Brandt's bat *Myotis brandti* and the re-assessment of the rarity scores of nine of the remaining 11 extant county species is likely not due to a legitimate increase in their numbers or a broadening of their distribution. It is, rather, attributable to the increase in recent years of higher quality acoustic monitoring devices and also to a concerted increase in the recording of cryptic and non-ubiquitous species in a previously under-studied and under-valued landscape.

Introduction

Mammals are generally under-recorded (Mammal Watch South East, 2015), with bats being a relatively understudied group (Jung and Kalko, 2010) and urban bats even more so (Kubista and Bruckner, 2015). Studies of urban bat assemblages have concluded that one or two adaptable species often dominate the urban landscape, typically accounting for more than 50% of bat records (Hourigan *et al.*, 2010) which, in the case of Birmingham and the Black Country, is accurate, with common pipistrelle *Pipistrellus pipistrellus* accounting for 46% of total bat records, 56% of all records identified to genus level and 64% of all records identified to species level at the start of the study (EcoRecord, 2018). This dominance by one or few species contributes to the general assumption that urban bat species richness is low, comprising only synurbic or synanthropic species that are well-adapted to light and noise. This assumption perpetuates a culture of under-recording within the conurbation which Teagle (1978) attributed to the preference of enthusiasts pursuing their interests in 'quieter, cleaner wilder places with more aesthetic appeal'.

In his seminal work, 'The Endless Village', Teagle (1978) undertook the first published work to explore the relationship between industry, culture and biodiversity in Birmingham and the Black Country and, though (as no bat records held by the local Biological Records Centre date from prior to 1983) there is no species list therein, he refers to the potential importance to bats of the disused limestone mines in Dudley. Robert Stebbings (1997) undertook surveys of the mines (arguably the most urban swarming site in the UK) and recorded the first (and until this study, only) county record for Brandt's bat. Up to and including 1996, the county database comprised 425 species-level records of seven species: Daubenton's bat *M. daubentonii,* whiskered bat *M. mystacinus,* Natterer's bat *M. nattereri,* noctule *Nyctalus noctula*, common pipistrelle and brown long-eared bat *Plecotus auritus*. Recording continued for another 20 years, with the species richness increasing to 11 by 2017 (Table 1).

Table 1: Published accounts of bat species assemblage of Birmingham and the Black Country.

Year	Publication	Spp.
1978	The Endless Village (Teagle, 1978)	?
1997	Survey for Bats: Dudley Limestone Mines (Stebbings, 1997)	7
2000	Bats Biodiveristy Action Plan (EcoRecord, 2000)	8*
2003	A Provisional Atlas of Mammals of Birmingham and the Black Country (Wyatt, 2003)	10
2007	The Endless Village Revisited (Shirley, 2007)	12
2010	Biodiversity Action Plan (The Birmingham and Black Country LBAP Review Group, 2010)	10
2017	A Standard Species Rarity Index (Slater and Carvalho, 2018)	11**
2017	Provisional Batlas of Birmingham and the Black Country (Jones, 2017)	11**

** In 1996 were two phonic types of common pipistrelle were found to be roosting separately (Park et al., 1996) and in 1999 were separated into two species: common pipistrelle and soprano pipistrelle P. pygmaeus (PTES, 2018) and as such prior to this date records of common pipistrelle have been retroactively assumed to be P. pipistrellus sensu lato but are likely to have represented both species rather than the actual county richness increasing after this date.*

*** The SSRI and Batlas included all records up to 15 and 10 years old, respectively at the dates of the assessments (with the SSRI comprising records from 2002 - 2017 and the Batlas from 2004 - 2014), both of which excluded Stebbing's record of Brandt's bat. The species was considered to be extinct in the region in 2017.*

Most studies of the effects of the anthropogenic environment on bats focus on the urban areas of Europe and North America (Jung and Threlfall, 2016). In general, these tend to focus on areas of either dense urbanisation, urban parks and gardens and industrial areas. A recent review of terminology and literature (Fischer *et al*., 2015) places emphasis on the importance of 'natural' areas in proximity to urban areas, but relatively little work has been undertaken to assess the importance of, or the bat assemblages within, urban fringe woodlands in temperate climates. Woodlands in metropolitan areas may be particularly important for bats (Avila-Flores and Fenton, 2005) but information on the effects of management of urban forests for bats is extremely limited (Smith and Gehrt, 2010). With increasing pressure to release green belt sites to meet rising housing needs (Birmingham City Council, 2017; Hearn, 2018), the under-valuing of urban fringe habitats is a threat to bat conservation in urban areas. With that in mind, in the spring of 2017 (two decades after Stebbings recorded the county's eighth species), the Birmingham and Black Country Bat Group prepared a plan for the Urban Bat Project and submitted a project licence application to begin advanced surveys in August of that year with a view to addressing the gaps in recording of urban woodland sites and the ultimate aim of producing a more accurate set of distribution data for bat species in the county.

Materials and Methods

Since August of 2017, advanced bat surveys have been undertaken at eleven woodlands (Figure 1) in the administrative area of Birmingham and the Black Country. Each site was subject to a minimum of three visits across each active bat season, comprising a total of 89 surveys. Surveys took place under Natural England project licences (2017-20732-SCI-SCI, 2018-33578-SCI-SCI, 2019-39455-SCI-SCI and 2019-44132-SCI-SCI) using standard

methodology (Kunz and Kurta, 1988; Barlow, 1999; Collins, 2016). As per Battersby (2010) and Collins (2016), surveys commenced at dusk; they continued for five trapping hours unless weather conditions curtailed the surveys.

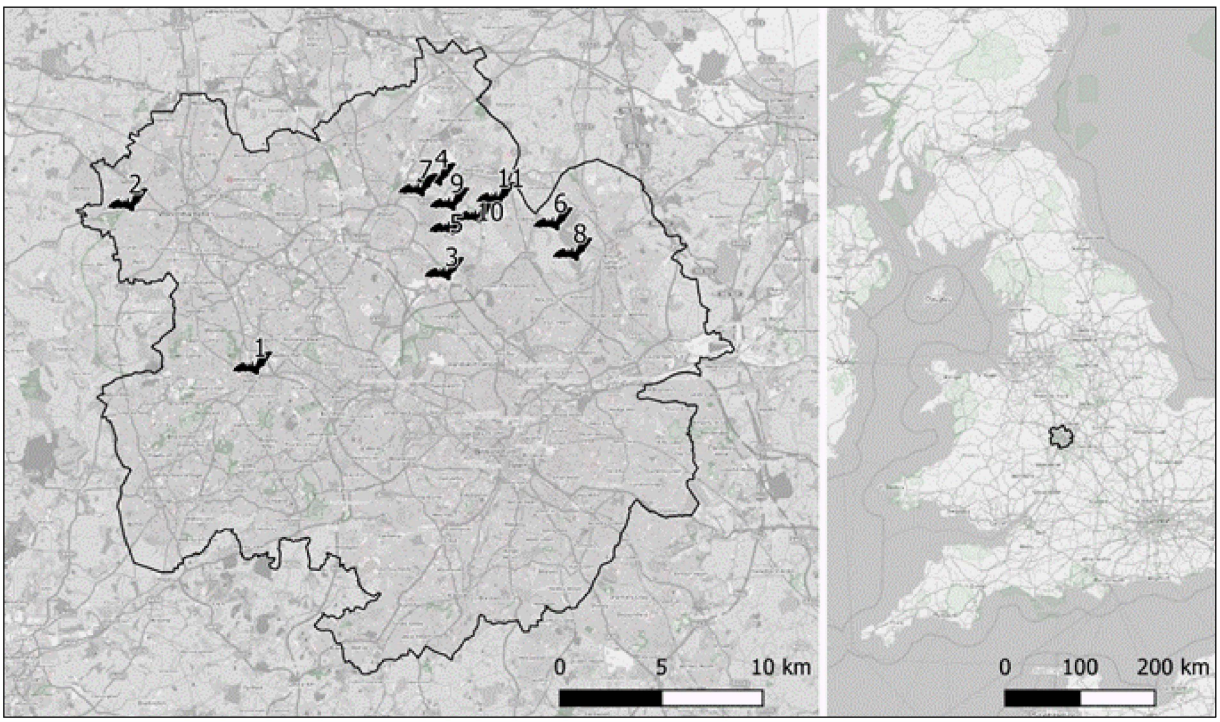


Figure 1: Location of woodland survey sites (numbered icons) within Birmingham and the Black Country (black) administrative boundary in its UK context. © OpenStreetMap 2020.

Figure 2: Surveyor setting up a harp trap at Park Lime Pits. © Gary Hughes.

Ecotone standard 4-shelf (2.4m high) mist nets were assembled into double-high arrangements in 6m, 9m or 12m lengths as canopy height allowed, supplemented by two

triple-bank Austbat harp traps deployed with Apodemus Batlure acoustic lures. Equipment at each survey was deployed to provide a minimum of two trap nights (Collins, 2016) and ten net hours (Pereira *et al*., 2009) per night. As per Bat Conservation Trust guidelines (Collins, 2016) acoustic monitoring supplemented the survey, with two Elekon Batlogger M bat detectors deployed for the duration of each survey. Data were collected utilising Epicollect5 (Imperial College London, 2019) and later compiled in SPSS (IBM Corp., 2016). Sound analysis was undertaken using Bat Explorer (Elekon AG, 2019) and records of catch data and acoustic monitoring were entered into the county database on MapMate (Mapmate Ltd., 2018) and imported into QGIS (QGIS Development Team, 2018) for graphical display using the TomBio plugin (Burkmar, 2020). Catch data were used to re-evaluate the county species assemblage utilising the Slater and Carvalho (2018) species rarity matrix (Figure 3).

Description		No. of Monads	No. of Tetrads	No. of 5km squares
Total Squares in Region		**747**	**202**	**40**
A	Abundant	over 682	over 190	over 38
VC	Very Common	501 — 682	141 — 190	28 — 38
C	Common	215 — 500	61 — 140	12 — 27
F	Frequent	86 — 214	24 — 60	5 — 11
U	Uncommon	31 — 85	9 — 23	2 — 4
R	Rare	7 — 30	2 — 8	1 & 3+ rec
VR	Very Rare	1 — 6	1	1 & < 3 rec
PE	Presumed Extinct	0	0	0
ABS	Absent	0	0	0

Figure 3: Criteria for rarity assessment (Reproduced with permission) (Slater and Carvalho, 2018).

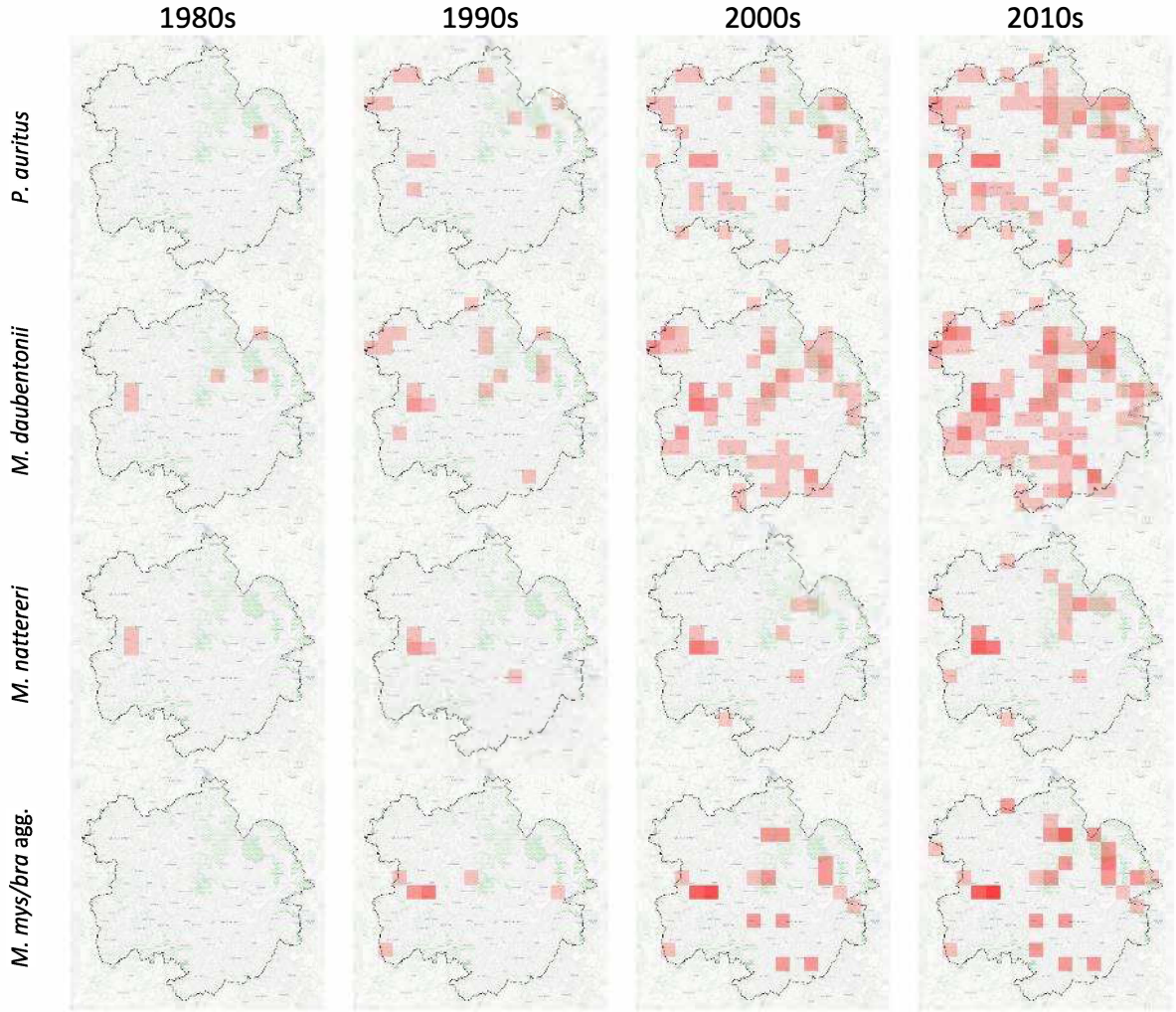
Results

A total of 699 bats have been caught so far comprising ten species: common pipistrelle (165), brown long-eared bat (152), Daubenton's bat (149), Natterer's bat (88), soprano pipistrelle (69), noctule (55), whiskered bat (12), Brandt's bat (5), lesser horseshoe bat *Rhinolophus hipposideros* (2) and Leisler's bat *N. leisleri* (1), with a further two species (serotine *Eptesicus serotinus* and Nathusius' pipistrelle *P. nathusii*) recorded on detectors. Based on monad count criteria, the data would warrant the reassessment of ten of the 12 county species (Table 2). Record density for key species by tetrad shows a notable increase in cumulative records (Table 3).

Table 2: Changes in count species rarity assessments based on the Standard Species Rarity Index (Slater and Carvalho, 2018) monads count.

Taxon	First recorded	2017 Monads	2017 Rarity	2020 Monads	2020 Rarity	Rarity Change	2020 Records
Noctule	1983	104	F	169	F	NC	638
Common pipistrelle	1985	365	C	566	VC	↑1	2942
Brown long-eared bat	1985	41	U	94	F	↑1	380
Daubenton's bat	1985	69	U	118	F	↑1	649
Whiskered bat	1986	2	VR	17	R	↑1	31
Natterer's bat	1988	10	R	23	R	NC	147
Brandt's bat	1997	0	PE	4	VR	↑1	7
Soprano pipistrelle	2000	99	F	218	C	↑1	729
Nathusius' pipistrelle	2002	4	VR	14	R	↑1	27
Serotine	2003	6	VR	20	R	↑1	28
Lesser horseshoe bat	2005	5	VR	9	R	↑1	26
Leisler's bat	2007	5	VR	26	R	↑1	48

Table 3: Changes in all-time record density per species (or aggregate) by decade. (Continued on next page.)



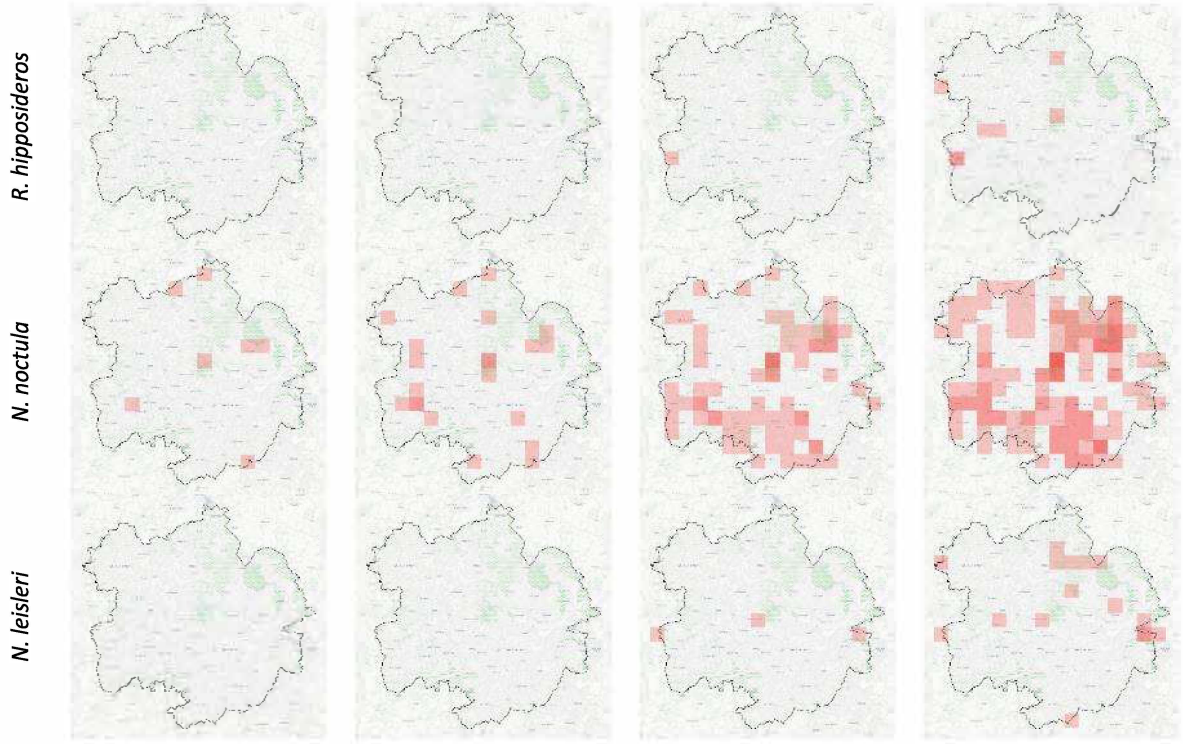


Figure 4: Brandt's bat, previously thought to be locally extinct; now found in four monads and widespread across the conurbation. © Morgan Hughes.

Numerous factors influence the quality, number and resolution of records in any county dataset. Improvements in recording equipment and sound analysis software, an increase in social media use and public engagement by NGOs, conservation organisations and universities, and the ongoing training of volunteers submitting their own records all contribute. There are numerous potential sources of species records in the county other than the surveys carried out in this study. These sources include bat care records, roost visits, surveys, and those submitted on an ad-hoc basis directly to record repositories.

However, an analysis of sources/recorders for the 2,199 species-specific records submitted since July 2017 shows that 80% derive directly from this study.

The findings of the study have demonstrated that the targeted surveying of a relatively small area (comprising just 2.9% of the area's woodland (Forestry Commission, 2018) and 0.9% of Birmingham and the Black Country's green belt (Natural England and CPRE, 2010)) has changed rarity assessments of all but two of the county's urban bat species. This indicates that there is a high degree of under-recording, with woodlands in the study area supporting a richer bat assemblage than previously assumed. Contributing factors to this under-recording may include recorder bias and the favouring of 'hot spots' and leaving the majority of the conurbation un-surveyed and its assemblage underestimated.

According to the EcoRecord criteria, none of the species within Birmingham and the Black Country now qualifies as 'Very Rare'. This is unlikely to represent an increase in abundance or distribution, but rather an increase in recording effort in a previously under-studied and under-valued environment.

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